

manufacturable as small as 12 cm³. For this reason the IISS/T is naturally adapted for in situ measurements. A network of deployed IISS/T may replace the vehicle-based system of sampling, currently used in the environmental monitoring. Alternatively, a network of low-resolution sensors coupled with a single processor is useful for random sampling, sequential sampling, or, when the processor is significantly more powerful than necessary for augmenting resolution and accuracy of a single spectrum, for simultaneous sampling. The main advantage of this solution would be an increase in the reliability and informativeness of environmental monitoring due to the continual sampling in situ. Such a network of IISS/T is useful in chemical, pharmaceutical and biotechnological industries for continual monitoring of manufacturing processes. The main advantage of this solution within those industries is an increase in the reliability and safety of manufacturing processes, as well as an improvement of the quality of production.

Without the digital processor performing spectral augmentation, no useful measurement results are obtained. This is distinct from existing spectral transducers having optical processing, the results of which are provided to an external processor for spectral analysis such as noise filtering and so forth.

The price of an IISS/T manufactured according to an embodiment of the invention, using standard integration technologies, is comparable with the price of a semiconductor device than that of classic spectrometer. The availability of such an IISS/T will change the approach to the use of light-spectrum-measurement-based techniques, currently limited to the laboratory environment for practical purposes. This invention provides a method of implementing a spectrometer for use in situ in many metrological applications.

Clearly, the use of the exemplary method described herein is not limited to the IISS/T. The method of spectral correction and resolution augmentation described above is useful in many applications other than a hand-help spectrometer. For example, in high precision measurement of spectra or in the design of lower cost high precision spectrometers. Similarly, the exemplary method of spectral enhancement performed in the processor of the IISS/T as described above, is an exemplary method of enhancing spectral accuracy and resolution. It is exemplary in nature and not intended to limit the scope of the inventive apparatus.

The exemplary embodiment of the invention presented above is not intended to limit the applicability of the method to the presented example. Neither is it intended to limit the variety of algorithms that may be used to embody the operations of the specialized digital signal processor. Numerous other embodiments may be envisaged without departing from the spirit or scope of the invention.

What is claimed is:

1. A spectrometer comprising:

a transducer comprising a dispersive element for dispersing light and a photodetector for converting the dispersed light into an electrical signal representative of spectral data, the transducer having a spectral resolution $R > 4$ nm; and,

a processor for enhancing the resolution of the spectral data to provide spectral data having a resolution of at least 2 times that of the transducer.

2. A spectrometer as defined in claim 1 wherein the transducer comprises a light diffraction grating having a spectral resolution R , $5 \text{ nm} \leq R \leq 15 \text{ nm}$, and wherein the spectral data provided by the processor has a resolution of at least 10 times that of the transducer.

3. A spectrometer as defined in claim 1 wherein the transducer is absent means for performing optical processing of the spectrum other than the dispersive element.

4. A spectrometer as defined in claim 1 wherein the transducer comprises a light diffraction grating having a lower spectral resolution than 5 nm and the spectral data provided by the processor is approximately that spectral data obtained using a spectrometer with a resolution of better than 2 nm.

5. A spectrometer as defined in claim 1 wherein a single integrated component comprises the transducer.

6. A spectrometer as defined in claim 1 wherein a single integrated component comprises the transducer and the processor.

7. A spectrometer as defined in claim 1 wherein the transducer is a broadband transducer for providing spectral data relating to a broadband spectrum.

8. A spectrometer as defined in claim 1 wherein the processor comprises

memory for storing data relating a spectrum of a sample the spectrum captured using the transducer and data relating to a substantially ideal spectrum of the sample; processing means for determining an estimate of another spectrum having a higher resolution from captured spectral data based on the data relating a spectrum of a sample to a substantially ideal spectrum of the same sample stored within the memory.

9. A spectrometer as defined in claim 8 comprising:

calibration means for receiving spectral information relating to the sample having a known spectrum, for determining the data relating the captured spectrum and the known spectrum, and for storing the data relating the captured spectrum and the known spectrum in memory.

10. A spectrometer as defined in claim 8 wherein the processor comprises calibration means for receiving spectral information $\{\tilde{y}_n^{cal}\}$ relating to the sample having a known spectrum $x^{cal}(\lambda)$, for choosing a form of an ideal peak $v_s(\lambda_s)$ and of projection operator \mathcal{G} and reconstruction operator \mathcal{R} for pre-processing the data $\{\tilde{y}_n^{cal}\}$, for determining parameters $P_{\mathcal{G}}$ of projection operator \mathcal{G} and parameters $P_{\mathcal{R}}$ of reconstruction operator \mathcal{R} and for storing the data relating a spectrum of a sample to a substantially ideal spectrum of the same sample in memory.

11. A spectrometer as defined in claim 10 wherein the processor is customized for use with the transducer.

12. A spectrometer as defined in claim 8 wherein the processor comprises:

means for estimating positions l of peaks within a spectrum on the basis of an estimate $\hat{s}(\lambda)$ of $s(\lambda; l, a)$;

means for estimating magnitudes a of the peaks; and,

means for iteratively correcting the estimates of the positions and magnitudes of the peaks.

13. A spectrometer as defined in claim 1 comprising a temperature transducer for providing temperature information to the processor and wherein the processor is for correcting errors in the spectral data in dependence upon sensed fluctuations in temperature.

14. A spectrometric sensor comprising:

a low resolution transducer consisting of a port for receiving electromagnetic radiation for measuring a spectrum thereof; a dispersive element for receiving the electromagnetic radiation received at the port, for dispersing the received electromagnetic radiation, and for providing the dispersed electromagnetic radiation; a photodetector for receiving the dispersed electromagnetic radiation from the dispersive element and for